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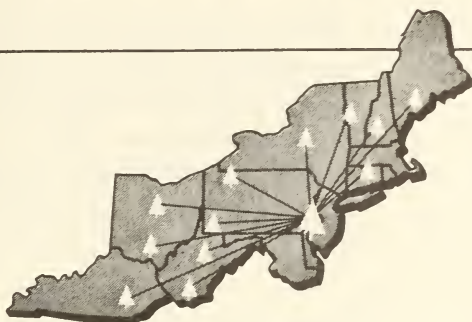


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# USDA FOREST SERVICE RESEARCH NOTE NE-143

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## Northeastern Forest Experiment Station



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### SOME CORRELATIONS BETWEEN SUGAR MAPLE TREE CHARACTERISTICS AND SAP AND SUGAR YIELDS

*Abstract.*—Simple correlation coefficients between various characteristics of sugar maple trees and sap sugar concentration, sap volume yield, and total sugar production are given for the 1968 sap season. Correlation coefficients in general indicated that individual tree characteristics that express tree and crown size are significantly related to sap volume yield and total sugar production. However, there was little evidence of a strong relationship between such tree characteristics and sap sugar concentration. Correlations presented were for one sap season only.

Sugarbush operators have always shown considerable interest in the relationships between sap yield and various characteristics of sugar maple trees. The sweetest sap, for instance, is thought by many to come from trees with wide, deep crowns characteristic of open-grown trees; and large trees in general are often thought to be particularly high sap volume yielders.

In the summer of 1968, researchers at the Sugar Maple Laboratory of the Northeastern Forest Experiment Station, in Burlington, Vermont, measured a number of characteristics of individual sugar maple trees, including diameter at breast height (d.b.h.), total height, average crown width, live crown length, crown ratio, and past growth (measured as the

average width of the last 10 annual rings). Sap volume yields, sap sugar concentration, and total sugar yield had been measured for the same trees for the 1968 sap season. In all, 30 trees in each of 3 sugarbushes are reported on here.

There are differences in the stand characteristics of the three sugarbushes. Sugarbush 1 is a dense stand about 75 years old. It has an average d.b.h. of about 12 inches and an average height of 57 feet. Sugarbushes 2 and 3, on the other hand, are old-growth bushes that are over 150 years old. Sugarbush 2 has an average d.b.h. of 24 inches and an average height of 80 feet. Sugarbush 3 has an average d.b.h. of 22 inches and an average height of 66 feet.

In the process of analyzing the data, correlation coefficients were calculated for simple linear relationships among the variables measured. Some of the correlation coefficients are presented here for each sugarbush, to illustrate the magnitude of relationships often observed in the field.

The relationship between two measures of tree size—d.b.h. and total height—and the yields of individual trees were examined. The correlation coefficients are:

<i>Tree size variable</i>	<i>Yield Variable</i>	<i>Sugarbush number—</i>		
		<i>1</i>	<i>2</i>	<i>3</i>
D.b.h. ....	Sap sugar concentration	0.34NS	0.11NS	0.21NS
	Sap volume yield	0.62**	0.55**	0.60**
	Total sugar production	0.67**	0.51**	0.58**
Total height .....	Sap sugar concentration	0.11NS	—0.13NS	0.33NS
	Sap volume yield	0.70**	0.46**	0.36*
	Total sugar production	0.61**	0.38**	0.39*

NS = Non-significant.

\* = Significant.

\*\* = Highly significant.

Correlation coefficients between the two measures of tree size and sap sugar concentration are very low and non-significant. However, there is a significant relationship between the two factors and sap-volume yield and total sugar production in all three sugarbushes. For sap yield and total sugar production, then, the data support the often-heard statement that, in general, larger trees yield more sap. However, there is no evidence that sap sugar concentration is related to tree size as measured by d.b.h. and total height.

The most talked about relationships in connection with yields from sugar maple trees are those between measures of crown size and yield:

<i>Crown size variable</i>	<i>Yield Variable</i>	<i>Sugarbush number—</i>		
		<i>1</i>	<i>2</i>	<i>3</i>
Average crown width	Sap sugar concentration	0.36*	—0.24NS	0.32NS
	Sap volume yield	0.50**	0.61**	0.66**
	Total sugar production	0.59**	0.46**	0.68**
Live crown length..	Sap sugar concentration	0.08NS	0.20NS	0.30NS
	Sap volume yield	0.59**	0.64**	0.54**
	Total sugar production	0.55**	0.63**	0.55**
Live crown ratio...	Sap sugar concentration	0.03NS	0.39*	0.21NS
	Sap volume yield	0.30NS	0.46**	0.56**
	Total sugar production	0.30NS	0.51**	0.55**

There are relatively large and, in most cases, highly significant correlations between sap volume yield, total sugar production, and the three measures of crown size, the only exception being with live crown ratio on sugarbush 1. However, correlation coefficients between these measures of crown size and sap sugar concentration are surprisingly low considering the emphasis most people give to crown size as related to sap sweetness. These relationships were non-significant on all of the sugarbushes except number 1.

There has been some speculation among maple producers about the relationship between tree vigor and yields of sap and sugar. In our study we measured past tree growth (an average width of the last 10 annual rings), which could be considered an index of relative tree vigor. Correlation coefficients between this variable and the yield variables are:

<i>Yield variable</i>	<i>Sugarbush number—</i>		
	<i>1</i>	<i>2</i>	<i>3</i>
Sap sugar concentration	0.36*	0.05NS	0.16NS
Sap volume yield	0.40*	0.34NS	0.55**
Total sugar production	0.49**	0.32NS	0.48**

There is a highly significant relationship between past growth and sap volume yield in sugarbush 3 and between past growth and total sugar production on sugarbushes 1 and 3. Translated into coefficients of determination, about 30 percent of the variation in sap volume yield is associated with past growth on sugarbush 3, and about 23 percent of the variation in total sugar production is associated with past growth on sugarbushes 1 and 3. However, no consistent trend is apparent.

The correlation coefficients between sap volume yield and sap sweetness for the three sugarbushes were non-significant. It should be remem-



bered however, that these correlations are for only one season. Marvin et al. (1969) found a significant correlation between the two variables over an 18-year period.

Correlation coefficients between sap volume yield and total sugar production (calculated from volume yield and sap sugar concentration) were 0.95\*\*, 0.93\*\* and 0.96\*\* on the three sugarbushes respectively. The correlation coefficients between sap sugar concentration and total sugar production were 0.57\*\*, 0.42\* and 0.49\*\*. Thus there is a stronger relationship between sap volume yield and total sugar production. With the use of labor-saving devices such as plastic tubing and vacuum systems, as well as the introduction of sophisticated processing techniques, the previous cost advantage of handling and processing sap with a higher than average sugar concentration may be unimportant. Of course, high sap sugar concentration combined with high sap volume yield will always be desirable.

The correlations presented in this paper indicate that individual tree characteristics that express tree and crown size, such as d.b.h., tree height, average crown width, live crown length and live crown ratio, are significantly related to sap volume yield. In general, we can say that big, large-crowned trees will yield more sap than small trees. However, contrary to popular belief in many quarters, there is little evidence of a strong relationship between these variables and sap sugar concentration. Obviously other variables that we did not measure are involved.

It should be mentioned again that the correlations presented in this paper are short-term correlations, for one season only. Correlations over many years may be quite different.

## Reference

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